EUROPEAN COMMISSION
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# The “Karlsruher Nuklidkarte”

*New Edition of the Karlsruhe Nuclide Chart*

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http://www.nuclides.net

# 110 years of Nuclear Science

- H.Becquerel 1896, discovery of radioactivity
- With Curie, Rutherford, Fermi, Hahn, Wigner, Bohr, Mottelson, many more advances in our knowledge of the structure of the nucleus
  Soddy, Moseley, De Hevesy ➡ isotopes
- Many Nobel prizes in Nuclear Science (including Physics, Chemistry, Physiology and Medicine)
- Since Gell-Mann, classification of hadrons with the quark model. Salam, Weinberg, Reines, Perl, Hooft, edification of the standard model

# Ordering the Knowledge

- Old concepts of “earth, wind, water and fire”
- Mendeleyev table (1869): Chemical properties, Mass Number
- Representation of nuclides in a proton/neutron map system (Fea, 1935, Seaborg, 1940, Segrè, 1945, Karlsruhe since 1958)
- Vision of the particles as multiplets of elementary particles (e.g. quarks for baryons)
- Supersymmetry, strings, etc ...

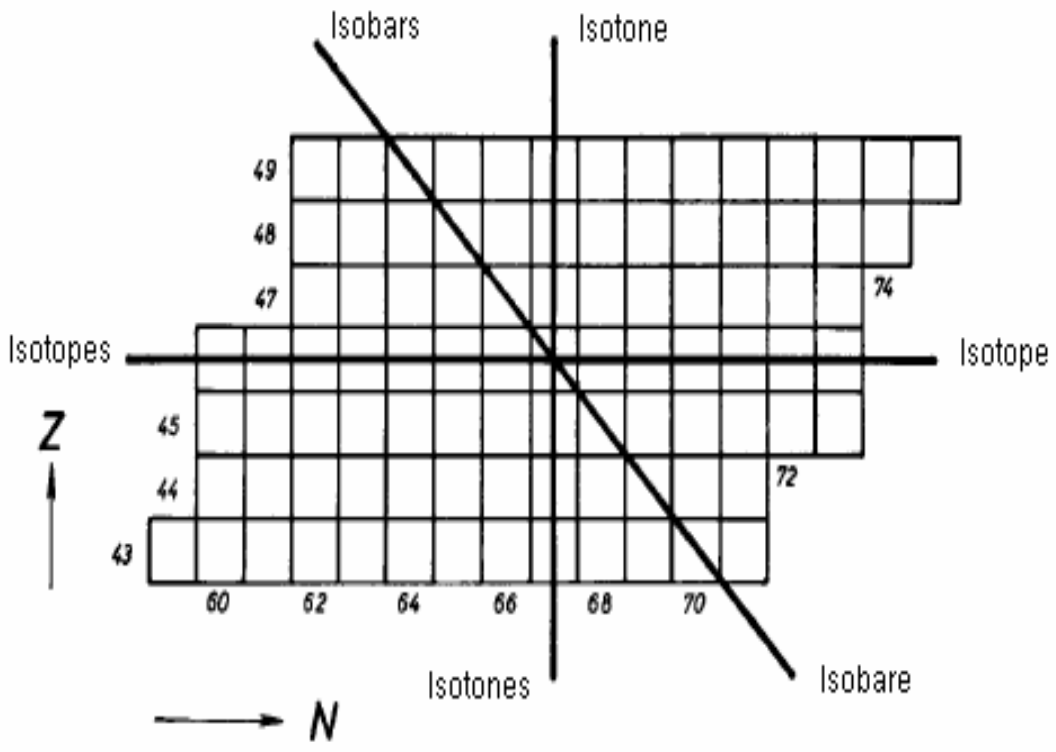
# The representation of the Nuclides

**Nuclide :** *A type of atom specified by its atomic number, Z, mass number, A, and energy state.*

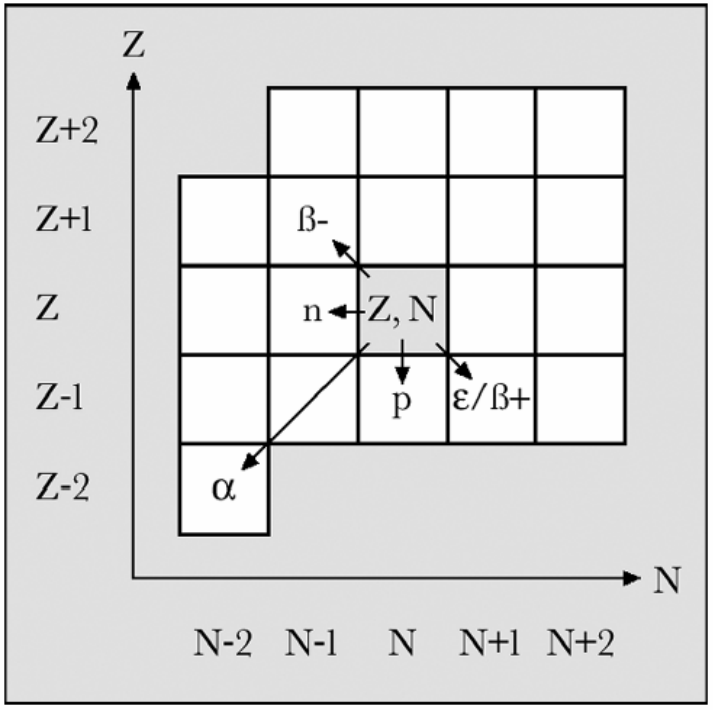
**Isotopes :** *meaning at the same place in the periodic table ➡ nuclides with same Z.*

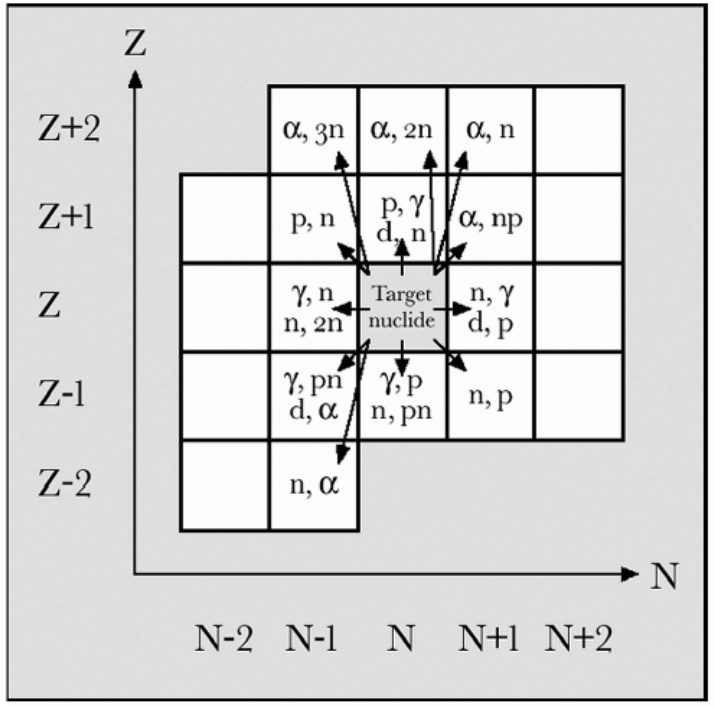
**Isotones :** *nuclides with the same N (=A-Z).*

**Isobars :** *nuclides with the same A.*



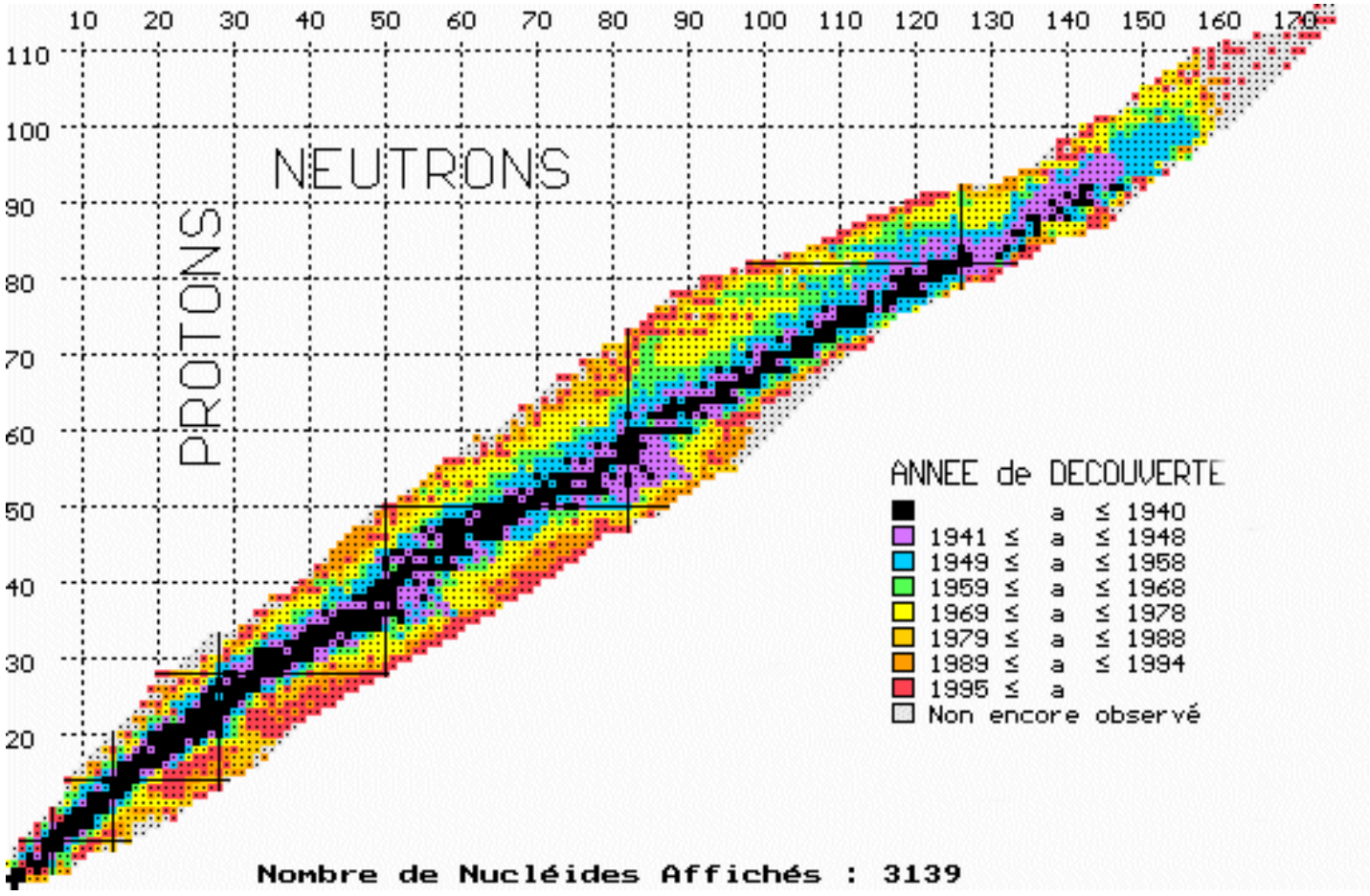
# Choices for the representation of data



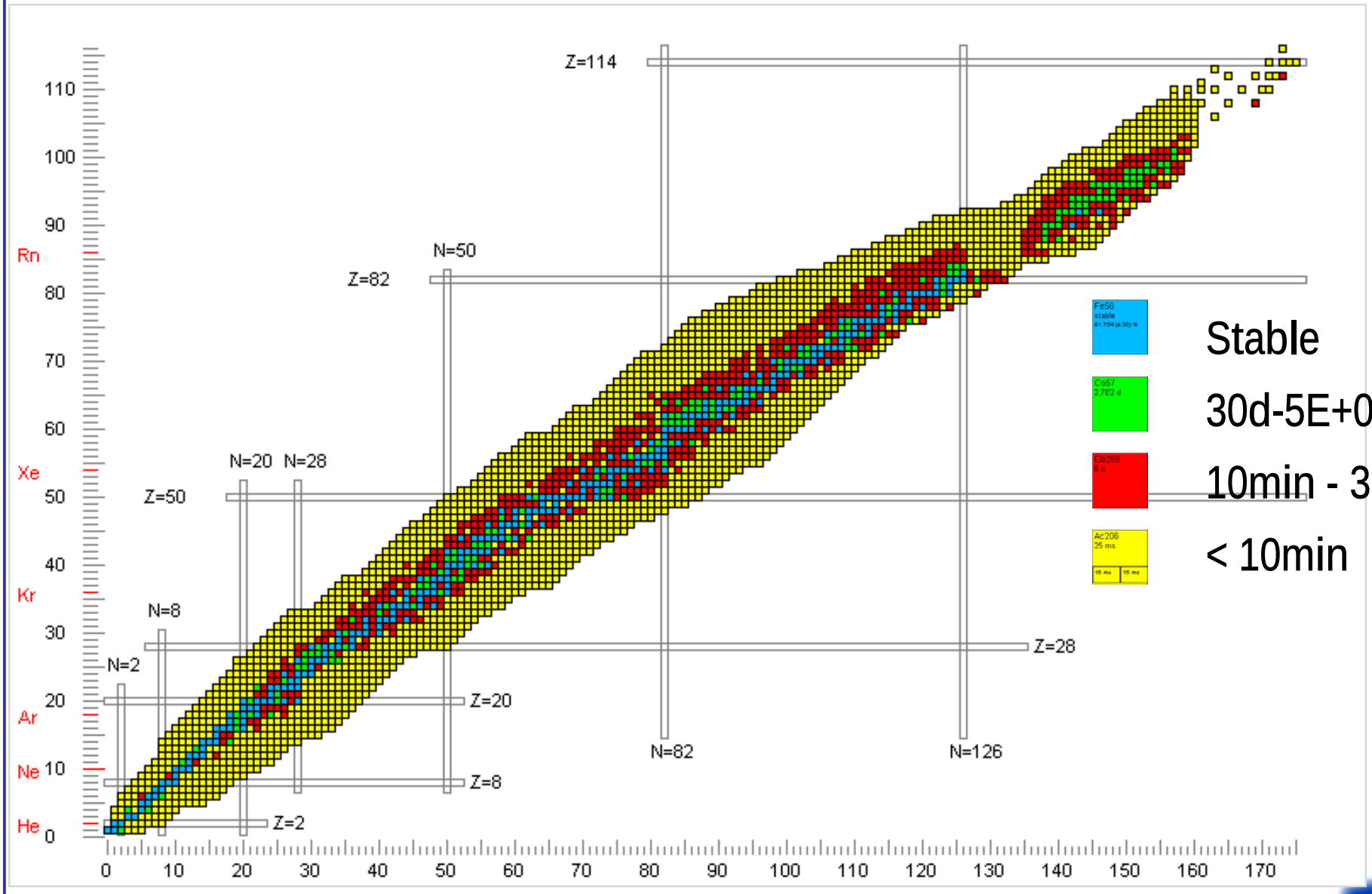

## Decay and nuclear reactions

# Choices for the representation of data



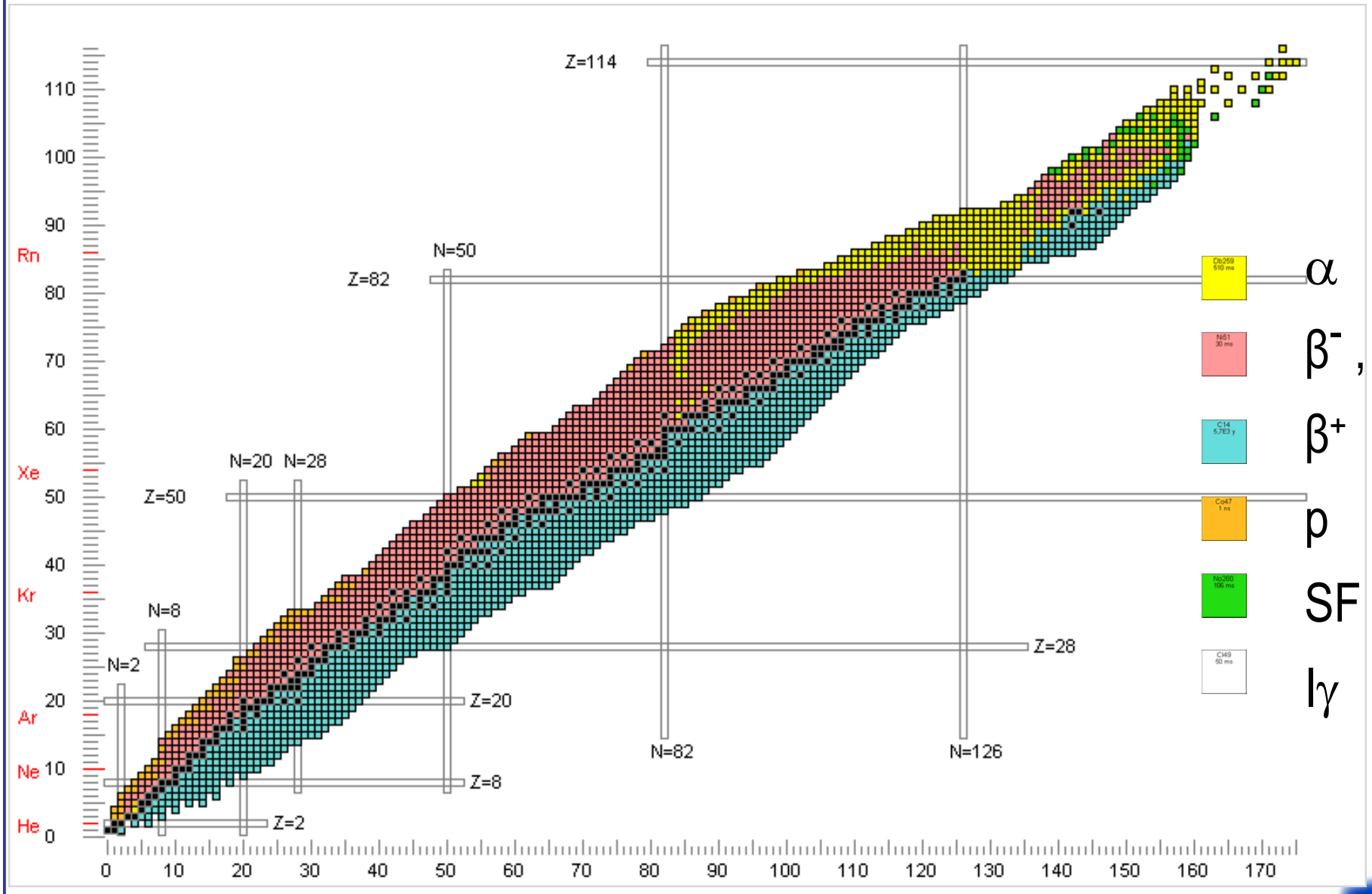

Historical point of view for the epistemologist

# Choices for the representation of data




Half-lives based

# Choices for the representation of data

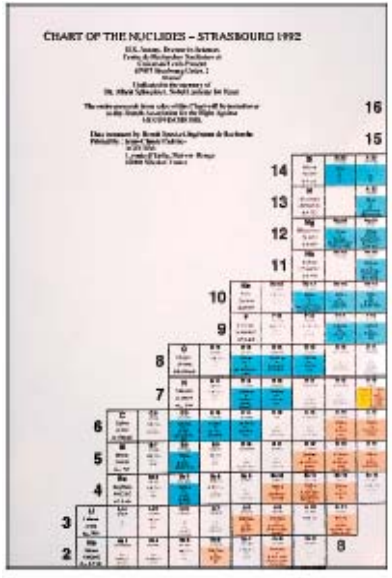


# Available Nuclide Charts

- Many charts are available mainly online with the recurring problem of the update and the reliability of the data
- Chart of The Nuclides 2002 Authored by Knolls Atomic Power Laboratory and distributed by Lockheed Martin (16th edition, revised to 2002, by E.M. Baum, H.D. Knox, and T.R. Miller).
- Chart of the Nuclides 2000 Japanese Nuclear Data Committee and Nuclear Data Centre, JAERI, 2000.
- Karlsruher Nuklidkarte 1998 6. Auflage, by G. Pfennig, H. Klewe-Nebenius, W. Seelmann-Eggebert.
- Strasbourg Chart of the Nuclides 1992 by M.S. Antony, Centre de Recherches Nucléaires et Université Louis Pasteur, Strasbourg, France.

# More Recent Popular Paper Nuclide Charts

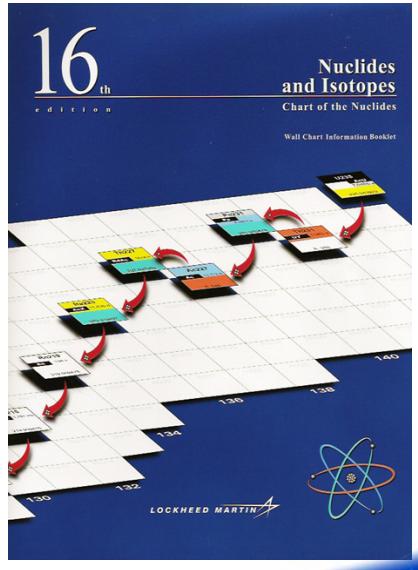
1992 1998 2000 2002




Strasbourg nuclide chart


Revised 6th edition of the "Karslruher Nuklidkarte"

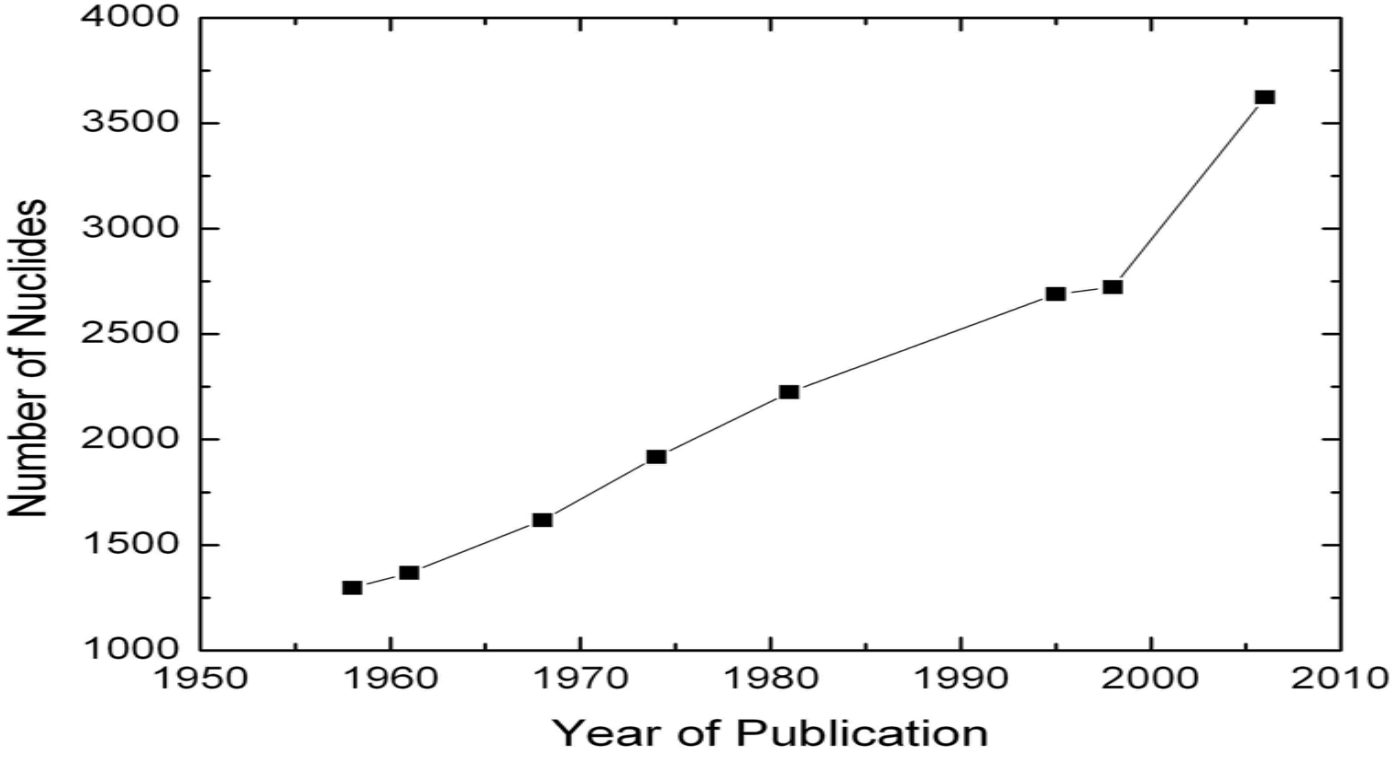

Japanese (JAERI) nuclide chart



# Discovery of New Nuclides

Number of Nuclides available in the Karlsruhe Nuclide Chart

The 7 editions, including 2006, are shown



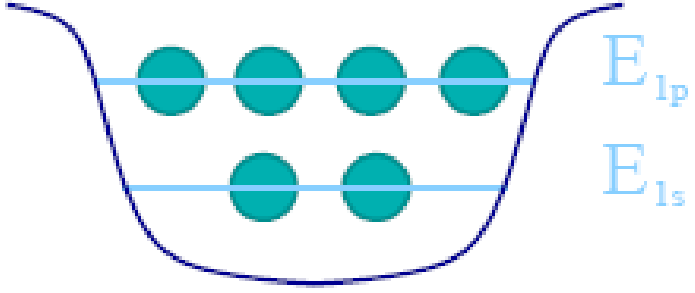
# New Nuclides discovered these last years

Magic numbers of protons and neutrons:

Nuclides with such numbers are favored in terms of stability

2,8,20,28,50,82,126

$^{4}_{2}He$ $^{16}_{8}O$ $^{40}_{20}Ca$ $^{48}_{20}Ca$ $^{208}_{82}Pb$




Doubly magic: $^{100}Sn$

Superheavy elements: $^{118}Uuo$, 2004

Superlarge nuclides, Halo nuclides: $^{11}Li$

# New Nuclides discovered these last years

"Quality frame" for nuclide data and discovery

0. dubious, contradictory data [Uuo-293]
1. only Z and A of the nuclide published [Rf-264]
2. and (one) mode of decay given [Hs-263]
3. and (estimation of) T1/2 given [Lr-262]
4. and spin given [Fm-255]
5. and mass given [Sg-265]

➡ Statistical data from the chart; no stable isobars for A=5 or 8
no stable isotopes for Z=43 or 61,
fixed number of nuclides with $T>10^9$ y

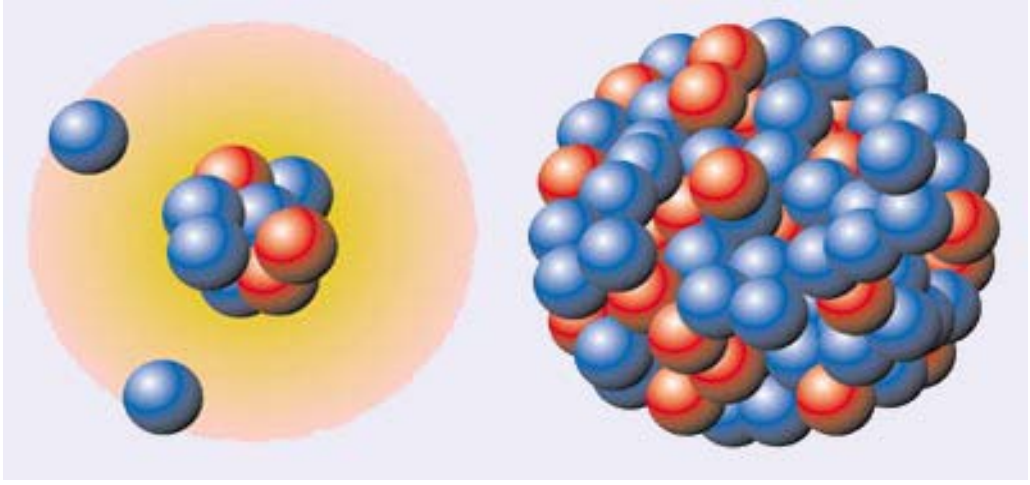
# Halo Nuclide $^{11}$Li

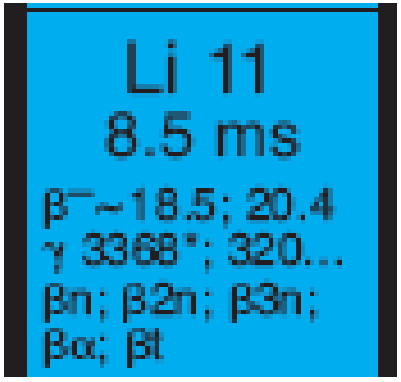
Superlarge (halo) nuclide $^{11}$Li :

a $^{9}$Li core with an orbiting two neutron halo.

Comparison with $^{208}$Pb

20 times heavier





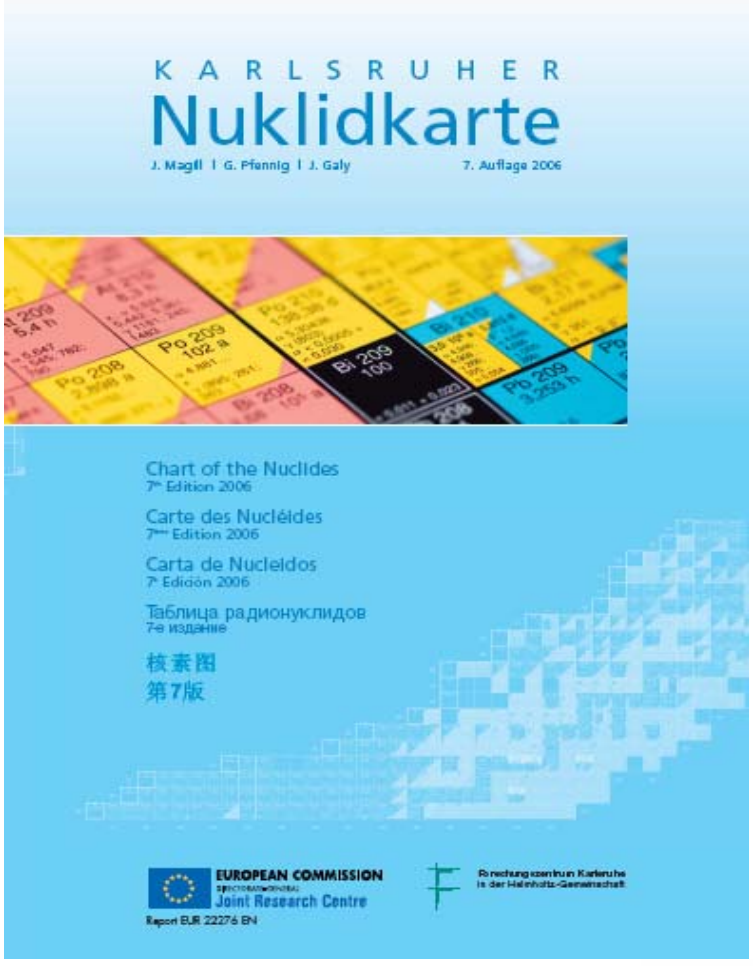

# A new version of the “Karlsruher Nuklidkarte”

New nuclides added and updates to known nuclides

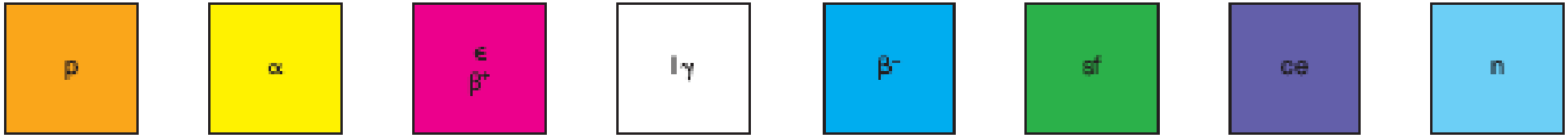
➡ Experimentally observed nuclides

➡ Colour scheme based on the decay modes. Multiple decay modes indicated.

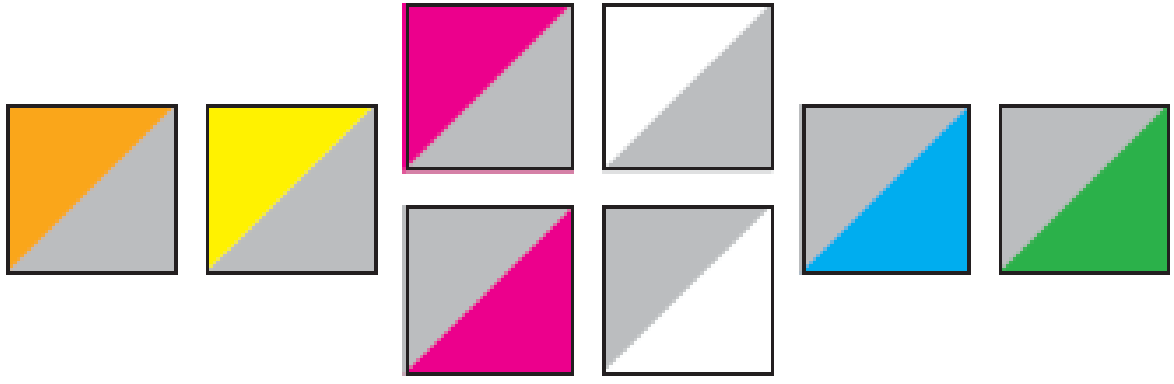
➡ Restricted but essential information shown



# Karlsruher Nuklidkarte Vademecum

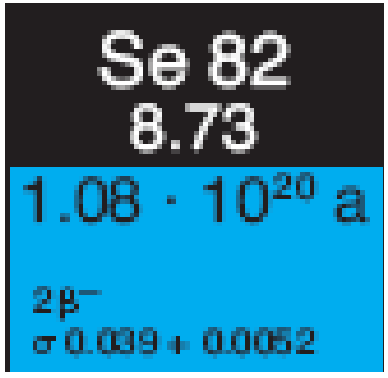


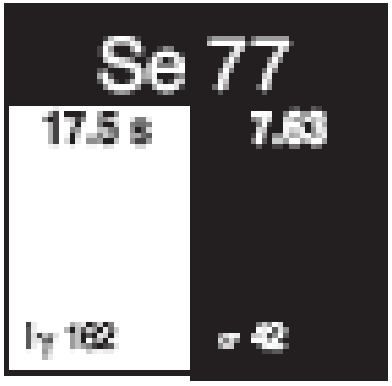

*Single Colour ⬅➡ Single Decay Mode*

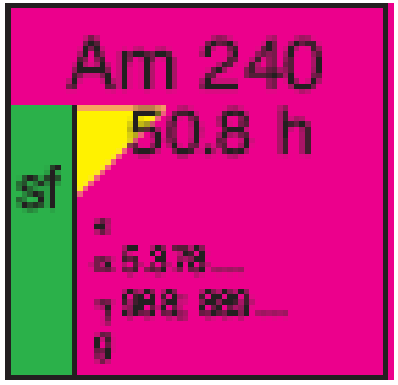


*Multiple Colours ⬅➡ Multiple Decay Modes*

# Karlsruher Nuklidkarte Vademecum

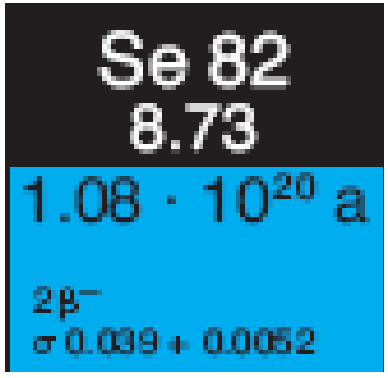


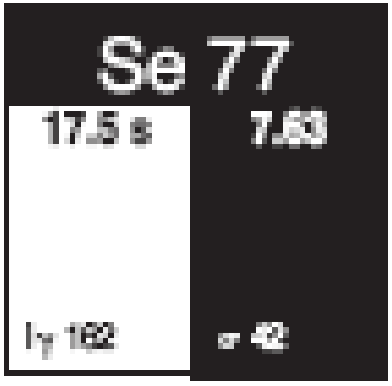



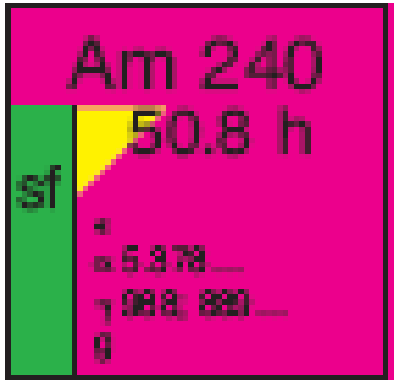




*Examples of 3 nuclides with different decay modes*

# Karlsruher Nuklidkarte Vademecum




*Selenium A=82*

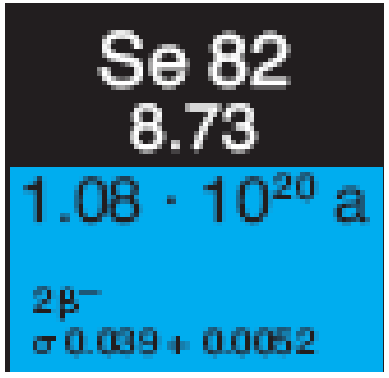
*Primordial element, abundance in the natural element 8.73%*

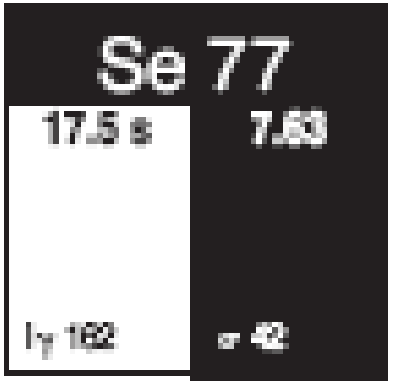
*$\beta^-$ decay with half-life of $1.08.10^{20}$ years*

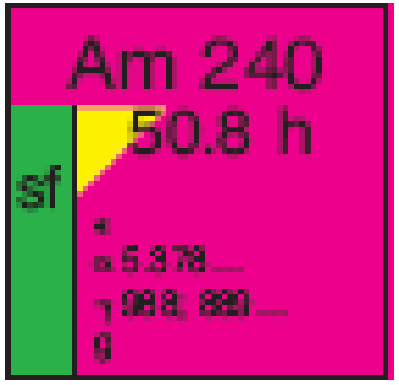
*Double beta decay*

*$(n,\gamma)$ cross section*

# Karlsruher Nuklidkarte Vademecum



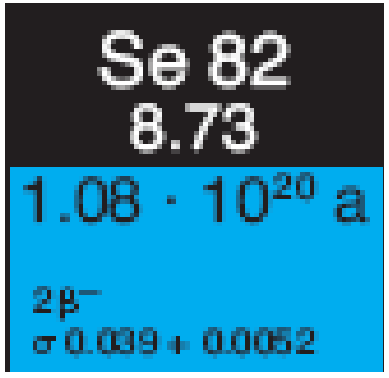



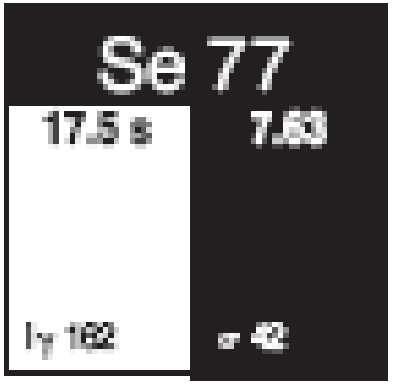



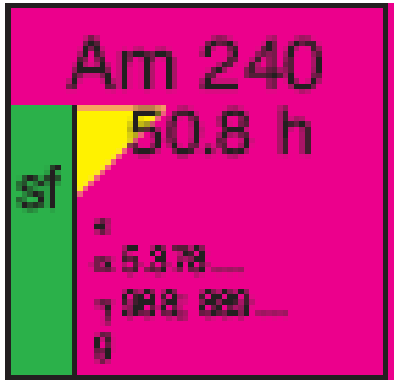

Selenium A=77

*<u>left hand side</u>: half-life of metastable state, 17.5 s;*
*γ-energy (162 keV) of the isomeric transition*
*<u>right hand side</u>: abundance in the natural element (7.63 %)*
*(n, γ)-cross sections for the thermal neutrons (barn)*

# Karlsruher Nuklidkarte Vademecum




*Americium A=240*

*<u>left hand side</u>: spontaneous fission isomer*

*<u>right hand side</u>: decay by electron capture and α decay. "g" indicates that the daughter Pu 240g is formed to at least 95 %; a population of Pu 240m up to 5% cannot be excluded*

# The New Version of the "Karlsruher Nuklidkarte"

- *612 updated nuclides*
- *Brochure with 2 new languages: Russian and Chinese(German, English, French, Spanish)*
- *Available soon*

  *7th edition*